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Abstract

INVESTIGATION OF SELF-DIFFUSION PROCESSES IN URANIUM AND ITS ALLOYS

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The main object of the present investigation was to study the anisotropy of the α- and β - uranium self-diffusion.

Due to the strong oxidability of uranium the conducting of experiments to study the self-diffusion in these phases presents considerable difficulties. The conditions were necessary under which the oxidation of the surface layer of the specimens in the course of the whole experiment would be brought to a minimum. Besides, the method for measuring the self-diffusion coefficient should be sensitive enough to permit the estimation of the alteration in the coefficients in different crystallographic directions.

With this purpose in view a procedure was developed for depositing an active isotope on the sample surface, for diffusion annealing and measuring the α-activity in the process of annealing in a high vacuum ($4\text{-}6 \times 10^{-7}$ mm Hg) without the vacuum being deteriorated between separate operations. Uranium-233 was used as a tracer. The self-diffusion coefficients were calculated from the alteration of the sample α-activity in the process of annealing (an adsorption method) and from the autoradiographs taken from the surface of the specimens after annealing.

The anisotropy of the α-uranium self-diffusion was studied using single crystals and coarse-grained polycrystal specimens whose grains are themselves perfect single crystals. The crystallographic orientation of the single crystals and individual grains was determined from the back reflection Laue patterns. In the case of β-uranium the experiments were carried out using only polycrystal specimens.

The variation in the blackening density vs the orientation of the grains both in the α - and β-phases is clearly seen in the autoradiographs, which

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is a conclusive proof of the anisotropy of the self-diffusion in these phases. It should be noted that in all the studies of the uranium self-diffusion published up to the present, the autoradiographic method failed to prove convincingly the anisotropy of the α - and β -uranium self-diffusion. It is in the present study that the autoradiographs were obtained for the first time, which show the dependence of the self-diffusion coefficient upon the crystallographic direction.

As a result of the investigation performed it was established that in α-uranium in (100) and (001) crystallographic directions the self-diffusion coefficient in the first approximation was the same and equal to 2×10^{-13} cm^2/sec while in (010) direction it was at a minimum and was approximately estimated to be less than 10^{-15} cm^2/sec. In the other crystallographic directions the self-diffusion coefficient is a function of an angle between a given direction and (010) axis. The preferred self-diffusion is found along the grain and subgrain boundaries. The self-diffusion along the boundaries is also anisotropic and is a function of the mutual orientation of the adjacent grains.

The crystallographic directions for the maximum and minimum values of the coefficient of the β -uranium self-diffusion have not been determined. The preferred self-diffusion is also observed along the grain boundaries.